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Abstract

BOILING HEAT TRANSFER AND BURNOUT MECHANISM IN BOILING-WATER COOLED REACTORS

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Experimental and theoretical studies on heat transfer and fluid flow in boiling-water cooled reactors have been pursued in the Japan Atomic Energy Research Institute since 1956.

The burnout phenomenon, which is one of the most important problems in heat transfer in boiling-water reactors, is discussed in this report. Causes of burnout and burnout heat flux were studied in its relation to the high heat transfer rate of boiling water and the two-phase flow phenomenon.

In studies in pool boiling, the growth rate of bubbles with low heat flux was investigated: experimental values agreed well with theory. For high heat flux, bubble behavior and change in time of temperature at the heating surface were observed, using a transparent electro-conductive glass heater. It was found that adherence of bubbles on the heating surface tended to increase rather than reduce the heat transfer rate. It is concluded therefore that burnout in pool boiling is caused not by the heating surface being covered by bubbles, but by the motion of combined and enlarged bubbles near this surface. This opened the possibility of predicting the burnout heat flux in pool boiling from an analysis of bubble motion, and predicted results were confirmed by experiment.

Experiments on burnout were also conducted for coolant flow channels. In the range approaching burnout flux, pressure, vapor generating rate and flow velocity were observed to present an oscillating phenomenon. From an analysis of these phenomena, it was established that the heat capacity of the heater and the flow characteristics of loops such as pump characteristics were also important factors affecting burnout. Flow oscillation was further investigated both experimentally and theoretically from the aspect of two-phase flow phenomenon.